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# PATENT SPECIFICATION (11) 1 438 583

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(21) Application No. 48601/73 (22) Filed 18 Oct. 1973

(44) Complete Specification published 9 June 1976

(51) INT CL² F27D 11/02
F27B 9/16
F26B 17/26

(52) Index at acceptance
F4B 7A11 A13A4A A13X A5B1 A5E1
A5E4
F4G 1E1 1E2 1K 1M1 4F1 4F2

(19)

## (54) IMPROVEMENTS IN OR RELATING TO VIBRATORY-CONVEYOR FURNACES

(71) We, VALERY PETROVICH SHULIKA, of Moskvorechie, 49, k.v. 10, JURY NIKOLAEVICH KHAZHINSKY, of Festivalnaya ulitsa, 3, kv.80, JURY FEDOROVICH YAKIMENKO, of Novo-Alexeevskaya ulitsa, 3, kv. 16, and ANATOLY VLADIMIROVICH SAVCHENKO, of ulitsa Vavilova, 56, korpus 1, kv. 19, all citizens of the Union of Soviet Socialist Republics, all of Moscow, U.S.S.R., do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to furnaces incorporating vibratory conveyors for moving materials to be heated through the furnaces, such furnaces being hereinafter termed vibratory-conveyor furnaces.

According to the invention there is provided a vibratory-conveyor furnace for granular materials, comprising a vibratory-conveyor for transporting material between loading and unloading means of the furnace, the conveyor including a vibratory channel following a curved path and mounted on support means by brackets in a manner enabling radial movement of the channel, the channel being electrically insulated from the support means by insulators, and the channel serving as an electrical-resistance heater for the furnace.

Embodiments of the invention will now be particularly described, by way of example, with reference to accompanying diagrammatic drawings, wherein:

Figure 1 is a part-sectional side elevation of a first vibratory-conveyor furnace embodying the invention;

Figure 2 is a section on line II-II of Figure 1;

Figure 3 is a section on line III-III of Figure 1;

Figure 4 is a simplified perspective view of the first furnace;

Figure 5 is a section on line V-V of Figure 2;

Figure 6 is a section on line VI-VI of Figure 5;

Figures 7 and 8 illustrate the operation of unloading means of the furnace;

Figure 9 is a section illustrating the means which mount a vibratory-conveyor channel of the first furnace on a support;

Figure 10 shows alternative means for mounting the channel on the support;

Figure 11 is a section through an insulator forming part of the channel-mounting means;

Figure 12 is an exploded perspective view of a second vibratory-conveyor furnace embodying the invention;

Figure 13 is a perspective view of the second furnace when enclosed in a supporting frame;

Figure 14 is a schematic diagram of the second furnace;

Figure 15 is a section on line XV-XV of Figure 14;

Figure 16 is a fragmentary perspective view of a support of the furnace;

Figure 17 is a section illustrating the means which mount a vibratory-conveyor channel of the furnace on the support of Figure 16;

Figure 18 is a perspective view of material loading means of the furnace;

Figure 19 is a plan view of the loading means of Figure 18;

Figure 20 is a section on line XX-XX of Figure 19;

Figure 21 is a simplified perspective view of the vibratory-conveyor channel and gas conduit layout;

Figure 22 is a perspective view of a third vibratory-conveyor furnace embodying the invention;

Figure 23 is an exploded perspective view of the third furnace;

Figure 24 is a schematic diagram of the third furnace;

Figure 25 is a part-sectional perspective view of the third furnace showing the layout of gas conduits of the furnace;

Figure 26 is a section illustrating the means which mount a vibratory-conveyor channel of the furnace within a column or support;

Figure 27 is a section on line XXVII-XXVII of Figure 26;

Figure 28 is a perspective view illustrating the layout of the channel-mounting means; and

Figure 29 is a section illustrating partial recycling of treated material in the third furnace.

The furnaces to be described hereinafter are for the heat treatment of granular materials including damp powdered materials normally poorly transportable by vibratory-conveyors. Heat treatment of such materials is generally accompanied by the evolution of gaseous products.

The first furnace has a vibratory-conveyor in the form of an annular channel with a typical working volume of $0.07m^3$ and is intended for heat-treating materials at a temperature of up to 550°C over an unlimited period of time. The form of the furnace permits material to be heat-treated in an inert atmosphere if so required. The working space of the furnace is dust-tight and can be evacuated if necessary.

By making the vibratory-conveyor annular in form, materials under treatment are periodically recycled back to where they were loaded onto the conveyor. Thus, materials which are damp when loaded into the furnace can be mixed with material dried in the furnace which greatly facilitates material transportation by the vibratory-conveyor. This is of importance for materials which are pasty in their initial state and also for processes in which the material is heated with liquid reagents in the furnace. A damp material lump moved round the furnace by the conveyor forms a dried-up crust which disintegrates under the effect of vibrations. Heating of the furnace is effected by passing an electrical current through the annular channel of the vibratory-conveyor; this gives a high heater reliability together with a low thermal time lag enabling rapid changes in the furnace temperature to be made if required.

A detailed description of the first furnace will now be given. As shown in Figures 1 and 4, channel 1 is rectangular in cross-section with rounded corners. The channel is mounted by brackets 2 which encompass the channel 1, on supports 3 forming part of a vertical support 4. Mounted on the bottom portion of the support 4 are four motor-vibrators 5 (Figures 1 and 3) energizable in pairs. Two of them generate helical oscillations under the effect of which the material being treated moves around the annular channel 1 (Figures 1 and 2) in a clockwise sense, in a top plan view, whereas the other two motor-vibrators 5 (Figures 1 and 2) cause material to move in an anti-clockwise sense around the channel 1. The motor-vibrators 5 are mounted with their shafts inclined to a horizontal plane. The angle of inclination of each motor-vibrator 5 to the horizontal plane determines the ratio of horizontal and vertical amplitudes of oscillations which, in turn, determines the degree of throwup and slippage of the material being treated as well as its stirring and degree of vibrofluidization. The motor-vibrators 5 are fastened by bolts 6 to respective plates 7 (Figures 1, 3 and 4) of the column support 4. Provision is made for changing the angle of inclination of the shafts of the motor-vibrators 5 to the horizontal plane in stepwise manner over the range of 0 to 90°. To this end each plate 7 is provided with a circular array of bolt holes 8 (Figure 4) uniformly spaced from each other and corresponding in size to the bolts 6 (Figure 1). Each plate 7 (Figures 1, 3 and 4) is welded to the bottom portion of the support 4 as a chord plane and is reinforced from the interior with horizontal stiffening ribs 9. This ensures adequate strength for the mounting arrangement of the motor-vibrators 5 along with a minimum weight.

The annular channel 1 (Figure 1) is enclosed in a detachable casing 10, the space therebetween being filled with heat-insulating mineral wool 11.

The annular channel 1 is heated owing to its ohmic resistance when connected in an electric heating circuit through flexible bus bars 12 (Figure 4). At the point of attachment of the flexible bus bars 12, adjacent portions of the annular channel 1 are connected through an electro-insulating connection 13 (Figures 2, 4 and 5) made as two flanges 14 and 15 (Figure 6) separated by an insulating plate 16. The insulating plate 16 is fitted with holes for coupling bolts 17 (Figures 5 and 6) located at its periphery; at the centre it has a rectangular port 18 similar in shape to the passage of the annular channel 1. The holes for the coupling bolts 17 provided in the flanges 14 and 15 are made of two sizes, the size of the smaller holes being slightly in excess of the tread diameter of the bolts 17, and the size of the larger holes being slightly in excess of the head diameter of the coupling bolts 17. The holes of smaller size in the flange 14 are located opposite to those of larger size in the flange 15, with those of larger and smaller sizes being arranged alternately in the flanges 14 and 15. The use of the coupling bolts 17 provides an air-tight, vibration-proof, reliable, small-size, heat-resistant and electro-insulating connection of the said adjacent portions of the annular channel 1.

For the sake of safety a material-loading pipe 19 (Figures 1 and 4) for loading the material being treated, a material-unloading pipe 20 for unloading the treated material, a gas outlet pipe 21 for the removal of gaseous products, and a sampling pipe 22 are provided with similar insulation from the channel 1. The treated material is discharged by unloading means (Figures 1, 4, 7 and 8) formed by a split section 23 in the bottom of the channel 1 whose edges overlap each other so that the right-hand edge (as shown in Figures 7 and 8) is bent upwards and the left-hand downwards. A slit formed between the edges of the bottom of the annular chute 1 terminates with the unloading branch pipe 20.

The channel 1 (Figures 9 and 10) with the brackets 2 is mounted on the supports 3 by bolts 24 and helical springs 25 (Figure 9) or disc springs 26 (Figure 10).

The tightening force of the bolts 24 (Figures 9 and 10) is adjustable and is set up during construction of the furnace such as to enable radial displacement of the channel 1 together with the brackets 2 during thermal expansion of the channel 1 by displacement of the bolts 24 along radial slots 27 provided in the horizontal plate of the support 3. The relative sizes of the channel 1 at 20°C and 500°C can be seen in Figure 2 in which the size of the channel at 500°C is shown in dashed lines. By allowing radial thermal expansion of the channel 1, stresses on the channel are greatly reduced.

The bolts 24 are electrically insulated from the channel 1 and the brackets 2 by insulators 28 whereby the supports 3 and the rest of the channel supporting structure is also insulated from the channel 1.

Each insulator 28 (Figure 11) comprises a ceramic collar 29 retained in outer and inner metal sockets 31 and 32 respectively, by beads 30 of these sockets.

Flat annular supporting surfaces of both the outer and inner metal sockets 31 and 32 are concentric and overlap each other in a plan view. The external supporting surface of the outer metal socket 31 is provided with an annular fillet 33 to locate the insulator 28 in an opening 34 of a bracket 2 of the channel 1.

The first furnace operates in the following manner.

A batch of material to be treated is charged through the loading pipe 19 (Figures 1 and 4) into the channel 1 which is resistance heated. When two motor-vibrators 5 are switched on the material being treated is conveyed clockwise around the bottom of the channel 1. Simultaneously it undergoes heat treatment lasting over the required time period. Gaseous products evolved are removed along the gas outlet pipe 21 mated through a flexible metal pipe 35 with an exhaust ventilation system.

During the operating cycle, the material being treated passes over the split section 23 in the bottom of the channel 1 (from right to left as shown in Figure 7), the directed vibrations causing the material to proceed further without entering the unloading pipe 20.

When the treated material is unloaded, its motional direction is reversed, the material now moving from the left to the right-hand side as shown in Figure 8, and the material enters into the slit section 23 to be discharged from the furnace.

Reversal of the motional direction of the material to effect unloading is brought about by switching over between the pairs of the motor-vibrators 5 (Figures 1 and 3).

The unloading means of the first furnace is reliable in service and prevents spilling of material being treated. If required, the pipe 20 for unloading the treated material can be utilized for drawing in ambient air. The first furnace can also be modified to operate in a continuous mode rather than in a batched mode.

The second furnace, to be described hereinafter, has a vibratory conveyor in the form of a helical channel with, typically, a working volume of 0.8m³. The furnace is intended for continuous treatment of loose materials, not liable to stick, at a temperature of up to 300°C for 20–25 minutes.

The helical channel 36 (Figure 12) of the vibratory conveyor of the second furnace is of a rectangular cross-section with rounded off corners and is fastened to a vertical support 37. In the bottom portion of the support 37 are mounted two vibrators 38 imparting helical vibrations to a vibrating system of the furnace including the channel 36. Under the effect of vibrations the material to be treated is conveyed along the helical channel 36 upwards from a loading pipe 39 (Figures 12 and 13) to an unloading pipe 40.

The entire vibratory system of the furnace rests on springs 41 (Figures 12 and 14) and is held at the top by tension members 42 with springs 43. The tension members 42 are fastened to an outer frame 44 (Figures 13 and 14) made as a three-dimensional structure formed by the sides of a parallelepiped. Suspended from the outer frame 44 are heat-insulating panels 45 made as folding doors.

The support 37 (Figure 15) has three vertical slots 46 spaced around its periphery at, for example, an angle of 120° to each other in a plan view. Each slot 46 accommodates a pair of vertical plates 47 (Figure 16) welded to the support 37 and connected by transverse horizontal supports 48. Attached to the horizontal supports 48 by bolts 49 (Figure 17) and springs 50 are radial brackets 51 (Figures 15 and 17) welded to the helical channel 36. Because the radial brackets 51 are bolted to the horizontal supports 48 (Figure 17) of the support 37 with

the aid of the bolts 49 spring-biased with the springs 50, the radial brackets 51 can be displaced radially with respect to the support 37, during thermal expansion of the helical channel 36 (Figures 15 and 17) by radial movement of the bolts 49 in respective slots 52 formed in the supports 48. Expansion of the channel is as a result of heating caused by current flow therethrough when connected in an electric heating circuit through flexible bus bars 53 (Figure 12).

The radial brackets 51 (Figures 15 and 17) of the helical channel 36 are insulated from the support 37 by the electric insulators 29 (Figures 11 and 17).

The loading pipe 39 (Figures 18, 19 and 20) is cylindrical in form and is connected to an intake turn of the helical channel 36 with the help of a pan with a bottom 54 sloping relative to a horizontal plane. Pan side walls 55 (Figure 19) are made arcuate and concave and merge smoothly with the outer cylindrical channel wall and with the loading pipe 39, the lines of junction A of the side walls 55 with the loading pipe 39 extending along the half of the cylindrical surface of the loading pipe which is remote from the channel 36. The junction elements of the loading pipe 39 and helical channel 36 can be made from stampings 56 of the helical channel 36, one of which is cross-hatched in Figure 19. Material being charged into the helical channel 36 through the loading pipe 39, will move down along the oblique bottom 54 of the pan and will simultaneously be urged against the concave side wall 55 which serves to turn the material to move tangentially to the channel. In this manner, material is smoothly fed into an intake turn of the helical channel, making it possible to avoid accumulation of damp material in the material loading means, to eliminate hazardous stress concentrations in the material intake of the helical channel 36 and to enhance the depth of filling of the helical channel 36 with the material to be treated.

The described form of the loading means of the furnace thus not only makes it possible to reduce the size of the loading means but to obviate accumulation of material therein.

A reduction in overall dimensions and weight of the loading means decreases inertial loads on the most stressed portions of the support 37 of the furnace. This, together with the elimination of stress concentrations through the use of radially displaceable constructional members, and with the reduction in the area of apertures in the column support 37, considerably enhances the operating reliability of the furnace.

The design of both the unloading pipe 40 and pipes 57 (Figure 21) for the removal of gases are similar to that of the pipe 39. Ventilation of the working space of the helical chute 36 is effected by drawing air through it. The air is supplied through air intakes 58 located on one side of the helical channel 36 and drawn off through the pipes 57 positioned diametrically opposite the intakes 58 and coupled through flexible pipes 59 to a vent header 60 itself coupled with an exhaust ventilation system.

The third vibratory-conveyor furnace will now be described, this furnace having a helical vibratory-conveyor channel with a typical working volume of 6m$^3$. The furnace is intended for the continuous heat treatment of loose material at a temperature of up to 500°C for 25–30 min., the volume of gases drawn off into a ventilation system of the furnace amounting to not more than, for example, 2000m$^3$/hr. The discharge rate is limited by the gas flow rate in the working volume of the furnace at which material dust carryover reaches an undesirable level. The gas discharge rate can be adjusted by varying the parameters of the exhaust ventilation system.

The third furnace (Figures 22 and 25) comprises a support in the form of a casing 61. The casing 61 accommodates an open helical channel 62 (Figures 24 and 25). In the bottom portion of the casing 61 two vibrators 38 are attached to a bracket 63 (Figures 23 and 24), the vibrators 38 imparting helical oscillations to a vibrating system of the furnace which includes the channel 62. The bracket 63 is bolted to the casing 61 through a terminal belt 64. The entire vibratory system of the furnace rests through springs 65 (Figures 23 and 24) on a frame 66 mounting a busbar panel 67 for supplying power through flexible busbars 68 to the resistance-heated open helical channel 62.

The gases being evolved are removed through diffuser D and a metal pipe 69 mounted axially in the top portion of the casing 61. Ambient air upon entering the working volume of the furnace is heated in a heating apparatus 70 (Figure 23) communicating with the furnace through a flexible air pipe 71. The material admitted into a loading pipe 72 of the form shown in Figure 18 is conveyed upwards to an unloading pipe 73 under the effect of helical oscillations. The unloading pipe 73 is mated with other technological equipment with the help of a flexible metal pipe 74 of a small cross-section.

The furnace assembly includes thermocouples 75 mounted on the casing 61 at selected points to enable monitoring and control of the furnace operation.

The casing 61 forming the support comprises inner and outer cylinder-shaped walls 76 and 77 (Figures 24 and 25). The inner cylindrical wall 76 is perforated to enable the channel 62 to be blasted with gases through openings 78 in the wall 76 located along the top edge of each turn of the open helical

channel 62. The space limited by the cylindrical wall 76 of the support has a bottom 79 in communication with the lowest turn of the open helical channel 62 through a chute 80. The space between the cylindrical walls 76 and 77 acts as a gas conduit for supplying ambient air through the openings 78 into the working volume of the vibration furnace. Air is fed from the heating apparatus 70 (Figure 23) to the space between the walls 76 and 77 through the flexible air pipe 71, and the space defined by the frusto-conical surfaces 81 and 82 (Figure 25), the external wall 77, and a throat 83, and four vertical shafts 84 of small cross-sectional area.

The speed of gas flow through the vertical shafts 84 precludes dust ejection from the working volume of the furnace into the surroundings. The vertical shafts 84 are located intermediate of the cylindrical walls 76 and 77. The bottom 85 of the gas conduit enclosed in the space between the cylindrical walls 76 and 77 is arranged above the lowest turn of the helical channel 62 and communicates with the latter through an aperture 86 (Figure 24) in the internal cylindrical wall 76 with the help of a chute 87.

Material spilled from the bottoms 79 and 85 is returned along the chutes 80 and 87 onto the lowest turn of the open helical channel 62 into a zone preceding the loading zone into which material is charged through the loading pipe 72.

The open helical channel 62 (Figures 26, 27 and 28) is secured to the supporting internal cylindrical wall 76 with the aid of radial brackets 88 attached to the internal cylindrical wall 76 and interconnected by gas-deflection plates 89 (Figures 24 and 28). The plates 89 serve to deflect gas moving radially inwards through the holes 78 onto material in the channel 62. In the zones of the radial brackets 88, the open helical channel 62 is furnished with radial crosspieces 90 (Figures 26 and 28) through which the open helical channel 62 is suspended with the help of bolts 91 and springs 92 from the radial brackets 88 (Figures 26 and 27). Owing to the bolted connection of the radial crosspieces 90 to the radial brackets 99 (with the bolts 91) the crosspieces 90 can be displaced radially along slots 93 (Figure 27) with respect to the radial bracket 88 on thermal expansion of the helical channel 62. The latter is heated owing to its ohmic resistance on being connected in an electric heating circuit through the flexible busbars 68 (Figure 23).

The radial crosspieces 90 (Figures 26 and 28) of the helical channel 62 are insulated from the radial bracket 88 by the electric insulators 28 (Figures 28 and 29).

The loading pipe 72 is mated with the intake turn of the helical channel 62 with the help of a pan with an oblique bottom in a manner similar to that previously described for the loading pipe 39 and channel 36 of the second furnace.

A material discharge pan 94 (Figure 29) of unloading means of the furnace is arranged to enable recycling of a fraction of the dried material to the lowest turn of the helical channel 62 to enhance thereby transportability of the starting materials which are liable to stick when damp. In this case the dried material passes from the discharge pan 94 through an opening 95 (the cross-sectional area of which is adjustable by a cone needle 96) onto an oblique pan 97. Then it proceeds along a vertical passage 98 into the bottom 85 of the gas conduit enclosed between the cylindrical walls 76 and 77. After that, the returned dried material pours through the hole 86 in the internal cylindrical wall 76, along the chute 87 onto the lowest turn of the helical channel 62 in the zone preceding the loading zone for the damp material. Spreading along the helical channel 62, the dried material forms a non-sticky interlayer between the surface of the helical channel 62 and sticky damp material which is being loaded. When the layers intermix under the effect of vibrations, aggregated lumps of the damp materials are coated (wrapped) with the dried material and do not stick to the surface of the helical channel 62 which improves the operation of the furnace and enhances its throughput capacity.

Adjacent the opening 95 provided in the bottom of the discharge pan 94, is provided a deflector 99 for accumulation of a fraction of the material being discharged near the opening 95. The latter is located above the oblique pan 97 at a distance therefrom at least equal to the desired maximum height of the layer of material on the oblique pan 97.

The cross-sectional area of the opening 95 is adjusted with the aid of the cone needle 96 which is arranged axially of the opening 95 and is set in position in accordance with the amount of material which is required to form the interlayer.

With the third furnace in operation, the material to be treated upon being admitted through the loading pipe 72 (Figures 23 and 24) to the lowest turn of the resistance-heated helical channel 62, is conveyed under the effect of helical oscillations along the helical channel 62 upwards to the unloading means, (the transfer of the material being treated is shown in Figures 24 and 25 by thick arrows, gas flow by thin arrows, and that of the dust and spilled material by dotted arrows). In terms of an electric circuit, the helical channel 62 is subdivided into three self-contained sections with individual temperature control systems. This permits a requisite preset distribution of temperatures in the helical channel 62 to be obtained during the heat-treating operation. As to vibration conditions, they may be chosen in accord-

ance with the process technological requirements by varying both the vibration amplitude and angle furnace.

Gaseous products of the heat-treating process are removed from the furnace working volume by drawing them off into the exhaust ventilation system through the diffuser D and the flexible metal pipe 69. The furnace can be ventilated either partially by removing only an excess volume of the gases evolved (in this case the opening for the flexible air pipe 71 is closed) or completely with a full removal of the gases liberated from the furnace by drawing ambient air through the furnace working volume. If that is the case, the air heated in the heating apparatus 70 flows along the flexible air pipe 71 into the space between the two surfaces 81 and 82 to be admitted through the shafts 84 into the bottom portion of the space enclosed between the cylindrical walls 76 and 77. Next the air enters the working area of the furnace through the openings 78 in the cylindrical wall 76 and on being directed by the gas-deflection plates 89 passes along the helical channel 62 to be discharged through the diffuser D into the exhaust ventilation system.

The described vibratory-conveyor furnaces can be advantageously used in the food, pharmaceutical, chemical and other industries, for high-temperature drying, roasting and heat-treating of granular materials. The furnaces can also be used as high-temperature chemical reactors for carrying out processes wherein strict adherence to prescribed technological parameters is necessary.

WHAT WE CLAIM IS:—

1. A vibratory-conveyor furnace for granular materials, comprising a vibratory-conveyor for transporting material between loading and unloading means of the furnace, the conveyor including a vibratory channel following a curved path and mounted on support means by brackets in a manner enabling radial movement of the channel, the channel being electrically insulated from the support means by insulators, and the channel serving as an electrical-resistance heater for the furnace.

2. A furnace according to claim 1, in which the brackets are attached to the support means by spring-biased bolts radially displaceable along radial slots provided in the support means, to move jointly with the channel.

3. A furnace according to claim 1 or claim 2, in which the channel is annular in form.

4. A furnace according to claim 1 or claim 2, in which the channel is helical and the loading means of the furnace comprises a cylindrical loading pipe communicating with the channel via a pan with an oblique bottom and concave side walls which merge smoothly with the loading pipe and with a cylindrical surface of the channel, the lines of junction of the concave side walls with the cylindrical loading pipe extending along the half of the cylindrical surface of the pipe which is remote from the channel.

5. A vibration furnace according to claim 1, claim 2, or claim 4, in which the channel is helical and the support means comprises spaced inner and outer cylindrical walls, the channel being mounted on the inside of the inner wall, and a bottom wall bounded by the internal cylindrical wall, the furnace including a chute vibratable to transport material from the bottom wall to the channel, and the space between the cylindrical walls forming a gas conduit the bottom of which communicates with the channel through an opening in the inner cylindrical wall, the inner wall being perforated to enable gas flow from the conduit onto the channel.

6. A furnace according to claim 5, in which the unloading means includes a discharge pan, a recycling passage enabling a fraction of the treated material to be recycled, the cross-sectional area of the passage being adjustable to adjust the fraction of material recycled.

7. A vibratory conveyor furnace substantially as hereinbefore described with reference to Figures 1 to 11, Figures 12 to 21, or Figures 22 to 29 of the accompanying drawings.

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Printed for Her Majesty's Stationery Office, by Croydon Printing Company Limited, Croydon, Surrey, 1976.
Published by The Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.

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9 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 1

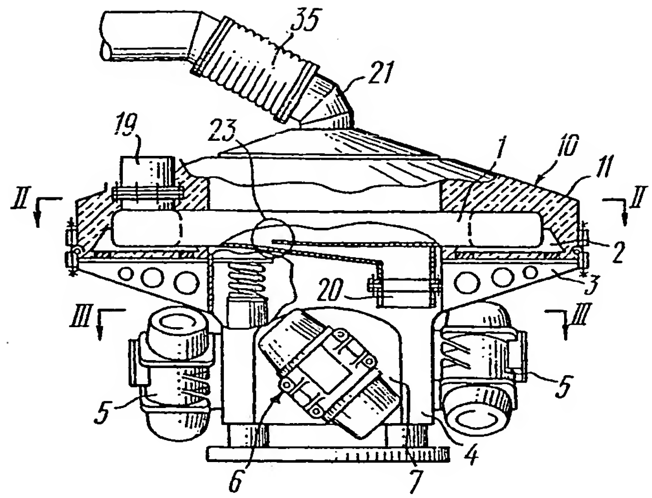


FIG. 1

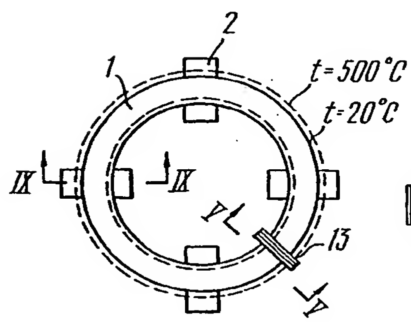


FIG. 2

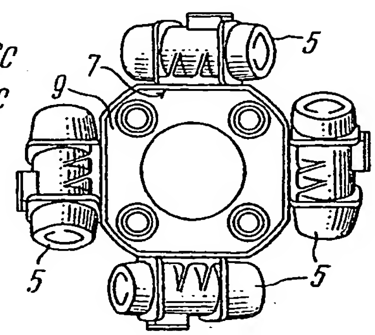


FIG. 3

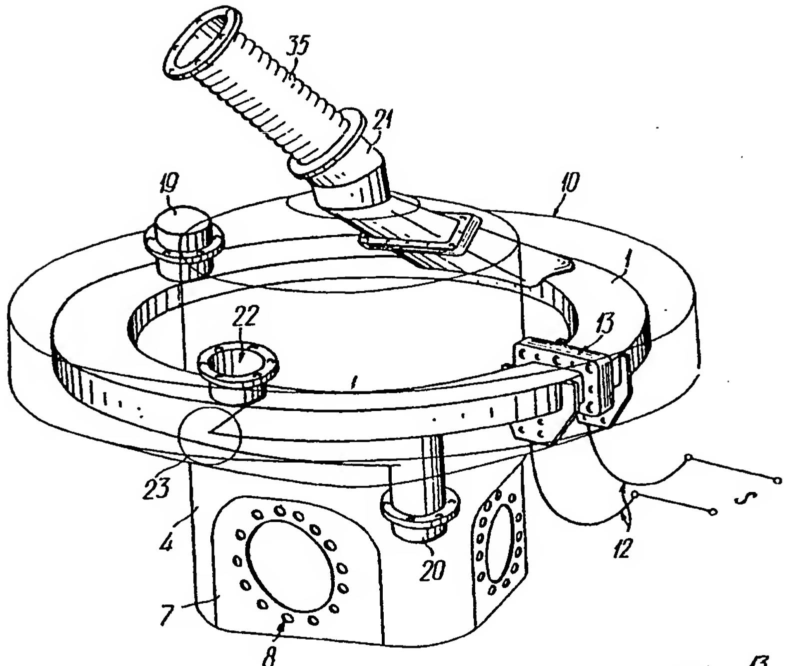


FIG. 4

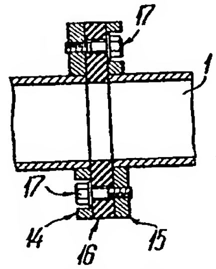


FIG. 6

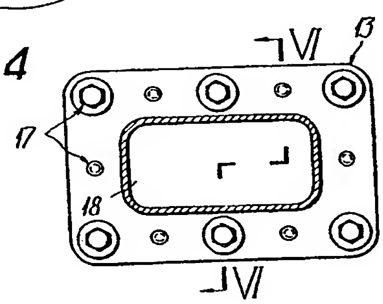


FIG. 5

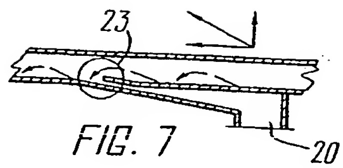


FIG. 7

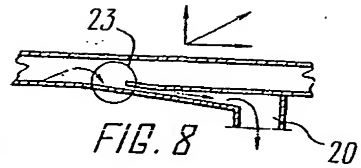


FIG. 8

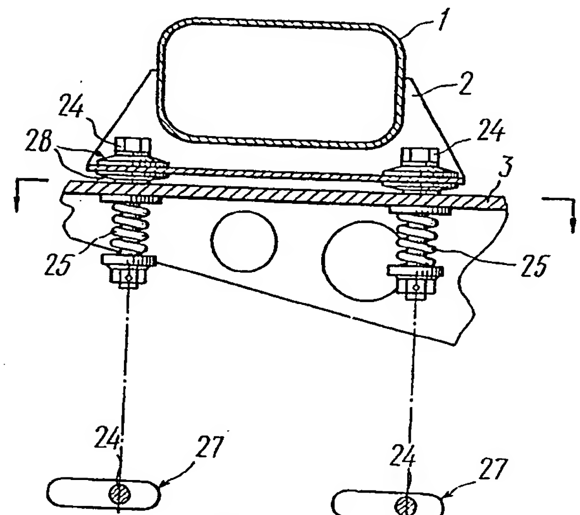


FIG. 9

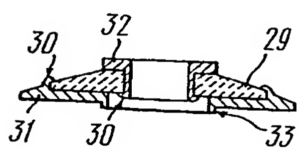


FIG. 11

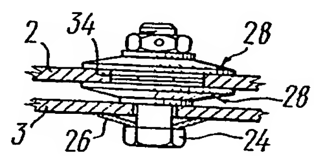


FIG. 10

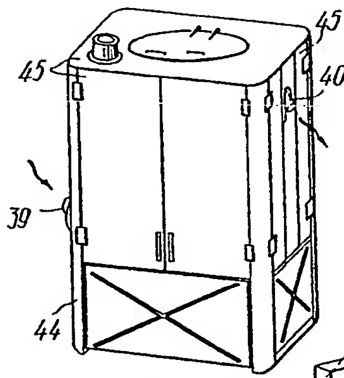


FIG. 13

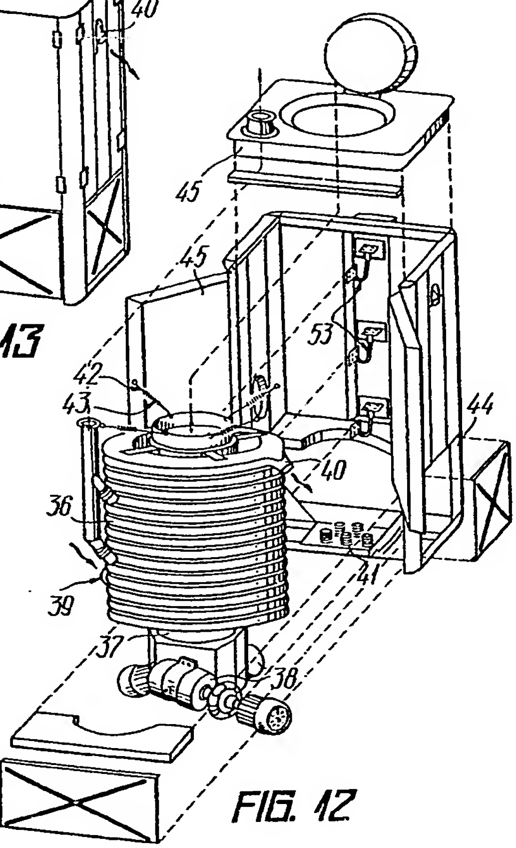


FIG. 12

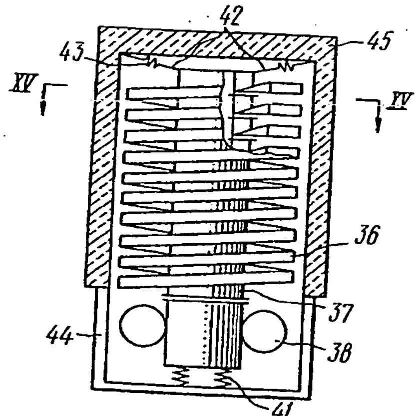


FIG.14

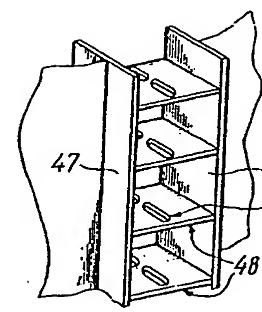


FIG. 16

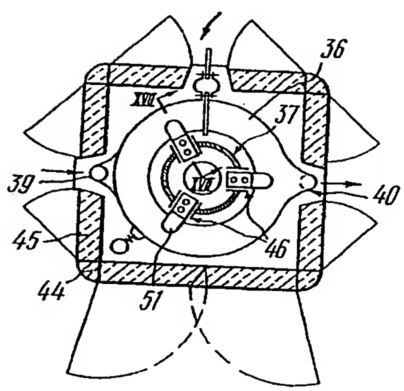


FIG.15

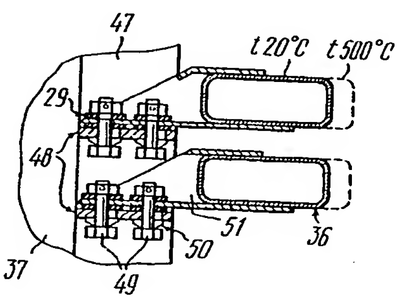


FIG. 17

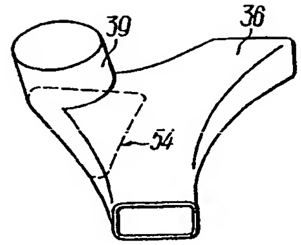


FIG. 18


FIG. 20

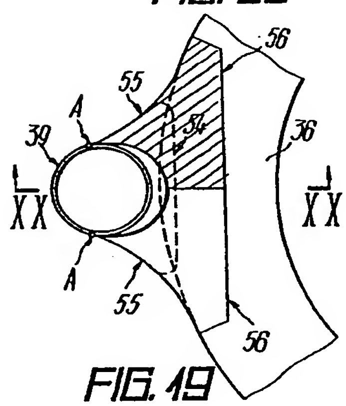


FIG. 19

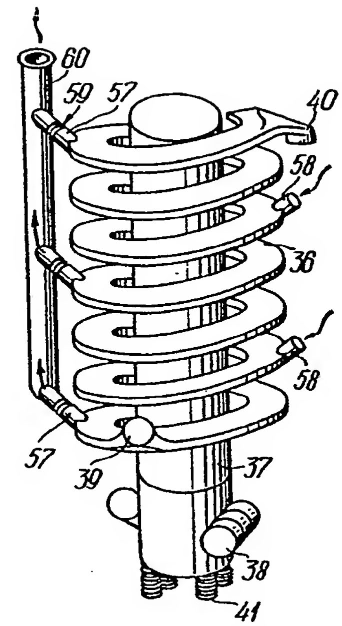


FIG. 21

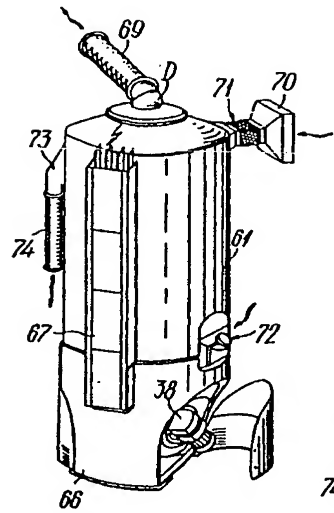
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FIG. 22

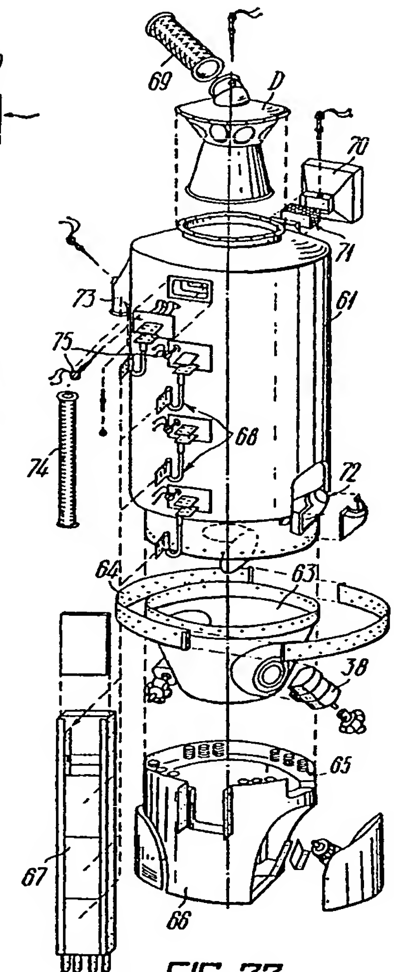
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FIG. 23

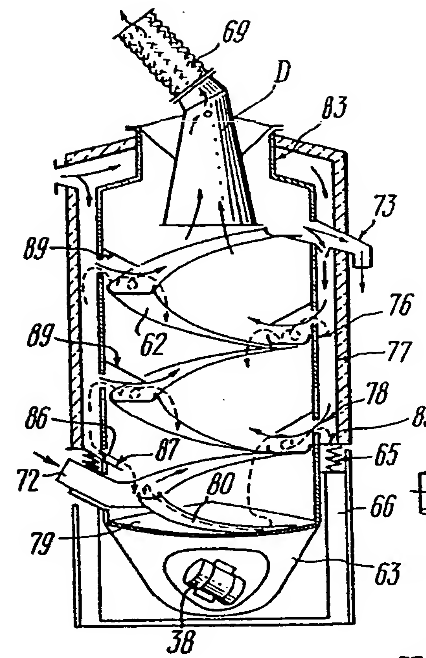
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FIG. 24

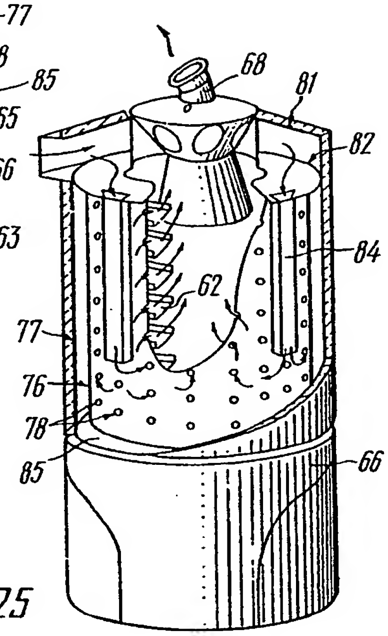
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FIG. 25

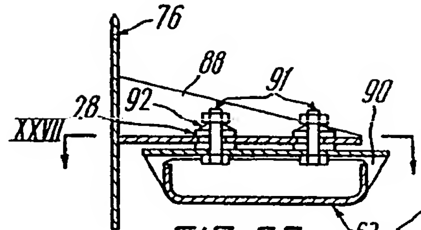


FIG. 26

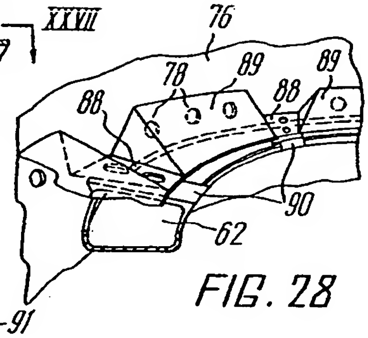


FIG. 28

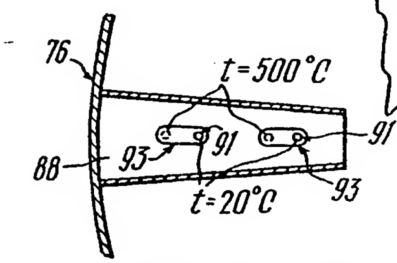


FIG. 27

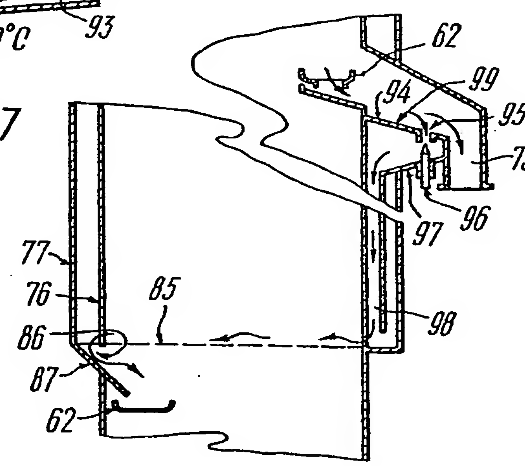


FIG. 29

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